Fluoroscopy radiation exposure

Well-indicated application of ionizing radiation and compliance with radiation protection principles remain mandatory to keep radiation exposure to patient and staff as low as reasonably achievable [1].

As further away as possible. Increasing the distance of the X-ray tube from the patient means that the dose to the patient's skin will decrease according to the inverse square law. On the other hand, placing the image intensifier (detector) as close to the patient as possible maximizes the intensity of radiation intercepted by the detector, resulting in reduction of radiation intensity produced by the X-ray source. It also leads to more efficient image acquisition and a possible overall decrease in fluoroscopy time and subsequent dose reduction for the patient. In conclusion, the operator should increase the distance of the X-ray tube from the patient as much as practicable and decrease the distance of imaging detector by as much as practically possible.

Distance from beam		Typical team member	Deep exposure	Superficial exposure
feet	meters		(mrem/min)	
Direct beam		patient	4000	
1	0.3	surgeon	20	29
2	0.6	assistant	6	10
3	0.9	scrub tech	0	≤ 2
5	1.5	anesthesiologist	0†	0†

* in a mock OR set up for maximal scatter

† after 10 minutes of exposure

Annual Maximum Permissible Dose Limits		
mrem	rem	
5,000	5	Whole Body Deep Dose Equivalent *(Head, trunk, active blood-forming organs & reproductive organs)*
50,000	50	Whole Body Shallow Dose Equivalent *(Skin of the whole body)*
15,000	15	Lens of Eye Dose Equivalent
50,000	50	Extremities *(Hands, forearms, feet and ankles)*

Imaging modalities used to visualize spinal anatomy intraoperatively include X-ray studies, fluoroscopy, and computed tomography (CT). All of these emit ionizing radiation.

Seventy-three patients underwent CT-navigated spinal instrumentation and 73 matched controls underwent spinal instrumentation with conventional fluoroscopy.

Effective doses of radiation to the patient when the surgical team was inside and outside of the room were analyzed. The number of postoperative imaging investigations between navigated and non-navigated cases was compared.

Intraoperative X-ray imaging, fluoroscopy, and CT dosages were recorded and standardized to effective doses. The number of postoperative imaging investigations was compared with the matched cohort of surgical cases. A literature review identified historical radiation exposure values for fluoroscopic-guided spinal instrumentation.

The 73 navigated operations involved an average of 5.44 levels of instrumentation. Thoracic and lumbar instrumentations had higher radiation emission from all modalities (CT, X-ray imaging, and fluoroscopy) compared with cervical cases (6.93 millisievert [mSv] vs. 2.34 mSv). Major deformity and degenerative cases involved more radiation emission than trauma or oncology cases (7.05 mSv vs. 4.20 mSv). On average, the total radiation dose to the patient was 8.7 times more than the radiation emitted when the surgical team was inside the operating room. Total radiation exposure to the patient was 2.77 times the values reported in the literature for thoracolumbar instrumentations performed without navigation. In comparison, the radiation emitted to the patient when the surgical team was inside the operating room was 2.50 lower than non-navigated thoracolumbar instrumentations. The average total radiation exposure to the patient was 5.69 mSv, a value less than a single routine lumbar CT scan (7.5 mSv). The average radiation exposure to the patient in the present study was approximately one quarter the recommended annual occupational radiation exposure. Navigation did not reduce the number of postoperative X-rays or CT scans obtained.

Intraoperative CT navigation increases the radiation exposure to the patient and reduces the radiation exposure to the surgeon when compared with values reported in the literature. Intraoperative CT navigation improves the accuracy of spine instrumentation with acceptable patient radiation exposure and reduced surgical team exposure. Surgeons should be aware of the implications of radiation exposure to both the patient and the surgical team when using intraoperative CT navigation [2].

The amount of radiation administered to 30 patients during 41 procedures in a controlled prospective trial over 6 months was assessed, comparing radiation exposure to the right and left hands in two neurosurgeons. Effective skin doses were evaluated using thermoluminescent finger dosimeters (ring dosimeters). The ratios of finger dosimeter exposure were compared between the glove-protected and unprotected left hands of two surgeons and both unprotected right hands. In addition, dose-area product (DAP) and fluoroscopy times were recorded in all patients. The mean treatment-effective dose to the surgeons' hands was 0.49 +/- 0.4 mSv in the glove-protected left hand and 1.81 +/- 1.31 mSv in the unprotected left hand ($p < 0.05$). The mean effective hand doses were 0.59 +/- 0.55 mSv in the unprotected right hand of the glove-protected surgeon and 0.62 +/- 0.55 mSv in the unprotected right hand of the control surgeon. The total corresponding fluoroscopy time was 38.55 minutes for the protected surgeon and 41.23 minutes for the unprotected one ($p > 0.05$). Lead glove shielding resulted in a radiation dose reduction of 75%. The total DAP for all procedures was 256,496 mGy/cm2 and 221,408 mGy/cm2 ($p > 0.05$) for the protected and unprotected surgeons, respectively.

CONCLUSIONS: This study emphasizes the importance of surgeons wearing lead glove protection on their leading hands during percutaneous vertebroplasty procedures and demonstrates a 75% reduction rate of exposure to radiation [3].

[1]

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